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Citation Analysis of Doctoral Theses of Earth Science accepted by the Manipur University during 1989-2011

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Abstract
The study is to analyse the bibliographic citations which have been cited in the doctoral theses of the research scholars in Earth Science, Manipur University, during the year 1981-2011.The study is to determine the principle forms of literature used in theses; to determine country-wise, language-wise and subject-wise distribution of literature; and the applicability of Bradford's law of scattering to the pattern used in Earth Science. The bibliographical references were used at the end of each chapter and end of the doctoral theses were taken as the source of data for the study. The collected data were analysed and interpreted with table's format. Analyses of several parameters like country-wise, language-wise, subject-wise distribution of literature and the applicability of Bradford's law of scattering. Interaction with faculties of concern department was carried out. It was found that researcher emphasized more on journal source, they depend literature from UK, Netherland & USA; English was the predominant language; the total 2273 citations of journals are scattered primarily among 45 subjects and 37.3% is connected in one major subject fields; 9 (Nine) Core journal which were the source journals leads the majority of the citations.

Keywords: Citation Analysis, Bradford Law, Earth Science, country-wise, language-wise, subject-wise.

Introduction
Citation analysis is one form of Bibliometrics study. It makes use of bibliographic references which are vital part of the primary scientific communication. The technique of citation analysis involves the process of collection, counting and analysis and interpretations of citations given in various types of literature and, thereby, helps in identification of significant sources of information, individuals, institutions and other aggregates of scientific activities. Citation analysis as a tool is used to identify the core references in a subject by counting the citations appended at the end of each scientific article. The author of a paper customarily presents references as authentic source of information having research value or to substantiate the point of view of ideas expressed in the cited paper. Analysis of cited papers is used as a measure of impact of individual articles, periodicals, authors, etc. and has become accepted practice in almost all scientific communications and is a well-established part of information research.

Review of Related Literature
Kapoor (1984) made the study under the title Citation analysis of Earth Science literature. In his finding features a ranking list of 82 journals representing 76% of total citations out of the 833 title cited. It was noted that as many as 422 journals had been cited only once. It also gives country-wise and subject-wise distributions of the journals in the ranked list. Rahman and Bhattacharya (2012) investigated 162 Ph.D. theses in Botany submitted to North Bengal

University during the period 1987 to 2007, The study revealed that journals appeared to be the most preferred sources of information contributing the highest number of citations (72.87%), followed by books (13.33%), seminar/conference (4.62%) and (2.85%)). The country wise scatterings of citations showed that India occupied first position with 21.13% of the total citations, followed by USA (19.79%) and UK (7.50%).Ravichandran, Sivaprasad and Manoharan (2014) carried out the bibliometric citation analysis of four Ph.D. theses in Library and Information Science at Bharathidasan University, Tiruchi during 2008-12. In all 791 citations were analyzed. The authors noted 68.9% articles published in journals, followed by electronic resources and others with a low percentage. The researchers cited only two languages, English (98.7%) and Chinese (1.26%). For country wise citations, the authors noted USA with 33% articles, UK 27.43%, India 25.41%, Netherland 8.34% and remaining 12 countries the articles were less than 2%. The journal distribution as per Bradford's law was noted to be 5:24:103. They also noted 85% of journal citations are 15 years old. Singh and Bebi (2013) carried out a citation analysis of Ph.D. theses in Sociology submitted to university of Delhi during the year 1995-2010. The study is based on the 5766 citations taken out from 25 Ph.D. theses of Sociology. The country wise-scattering of citations reveals that 2536 (45.52%) citations were from India and it was followed by USA and UK. Kushkowski (2003) reported on a result of a study of over 9,100 citations from 629 masters and doctoral theses written between 1973 and 1992 at a Midwestern Land Grant University. The study suggests that graduate students writing theses favour current research. The study shows distinct trend in graduate students' citation pattern.

Scope

The present study is an attempts to discover and scanning of the Ph.D theses of the Earth Science department during the period 1989-2011; present study attempts on the pattern of information use by researchers in the field of Earth Science; and area of study has confined to the Ph.D theses of Earth Science declared by Manipur University for the degree of Philosophy.

Objectives

The objectives of the study are to:

(i) Study the Major source of information used in Earth Science and to determine the principal forms of literature used in theses by Earth Science doctoral students;
(ii) To determine country-wise, language-wise and subject-wise distribution of literature used by doctoral students.
(iii) Applicability of Bradford's law of scattering to the pattern used in Earth Science.

Methodology

The information were collected from Manipur University which was submitted during the period of 1989-2011 in Earth Science department were recorded the task of identifying and recording information about the individual citation. The bibliographical references which were used by the researchers for completing the theses at the end of each chapter and end of the doctoral theses were taken as the source of data for the study. The collected data was classified, tabulated, presented, analyzed and interpreted with the help of tables. The study presents analysis of several parameters like forms of literature, Country-Wise, LanguageWise, Subject-Wise and finally a list of core journals was compiled and prepared on the basis of highly cited articles of the journals in Earth Sciences.

Limitations of the study

(i) The scope of the study is restricted to the research work thesis conducted by the Department of Earth Science, Manipur University.
(ii) The analysis of the study base on journal sources.
(iii) The present study carried that available doctoral theses in University libraries and departments which taken up for detailed investigation.

Analysis of Data

Data Collected from the Thesis

A total number of 36 (thirty six) theses submitted to Manipur University during the period of 1989-2011 in Earth Science department were examined. They gave a total of citations, which is an average of 100.45 citations per thesis. The bibliography cited was sorted out according to theirs formats, i.e. books, journals, proceedings, thesis, report, records and others. Journals have a highest ranking to be cited by the researchers of Earth Science. The data collected were presented in table's aid percentages under various heading.

Table 1. Year-Wise Distribution of Thesis

Sl. No.	*Year*	*Rank*	*Thesis*	*Percentage %*
1.	2002-2007	1st	12	33.33
2.	1990-1995	2nd	10	27.78
3.	2008-2011	3rd	7	19.44
4.	1996-2001	4th	5	13.89
5.	1984-1989	5th	2	5.56
			Total = 36	100

From Table-1 it reveals that during 2002-2007, the total thesis was 12 and this period was the most producing Ph.D thesis as compare to other years and followed by the years 1990-1995, 2008-2011, 1996-2001 and 1984-1989 respectively.

Bibliographic Forms of Cited documents

The following Table-2 gives us details about the different documents cited by the scholars.

Table 2. Source-Wise Distribution of Citation

Sl. No.	*Bibliographic Forms*	*No. of Citations*	*%*	*Cumulative No. of Citations*	*Cumulative Percentage (%)*	*Rank*
1.	Books	1878	30.72	1878	30.72	2nd
2.	Journals	2273	37.18	4151	67.89	1st
3.	Proceedings	872	14.26	5023	82.16	3rd
4.	Reports	371	6.07	5394	88.22	4th
5.	Records	245	4.01	5639	92.23	5th
6.	Thesis	196	3.21	5835	95.44	6th
7.	Government Publication	161	2.63	5996	98.07	7th
8.	Maps	15	0.25	6011	98.32	9th
9.	Misc.	103	1.68	6114	100.00	8th
	Total	6114	100.00			

It is observed that from Table-2, 37.18% of the sources cited by the doctoral researchers are journals followed by books (30.72%), Proceedings (14.26%), Reports (6.07%), Records

(4.01%), Thesis (3.21%), Government (2.63%), Miscellaneous (1.68%) and Maps (0.25%) respectively.

Country-Wise Distribution of Journal

Table 3. Country-Wise Citations in Earth Science

Sl. No.	*Name of the Country*	*No. of Citations*	*Cumulative Citations*	*Percentage (%)*	*Cumulative Percentage*
1.	UK	700	700	30.796	30.796
2.	Netherlands	365	1065	16.058	46.854
3.	USA	353	1418	15.530	62.384
4.	India	234	1652	10.294	72.679
5.	Nigeria	199	1851	8.754	81.434
6.	Germany	115	1966	5.059	86.493
7.	Kenya	42	2008	1.847	88.341
8.	Australia	35	2043	1.539	89.881
9.	Switzerland	29	2072	1.275	91.157
10.	Canada	27	2099	1.187	92.344
11.	USSR	25	2124	1.099	93.444
12.	Italy	16	2140	0.703	94.148
13.	Thailand	15	2155	0.659	94.808
14.	Austria	12	2167	0.527	95.336
15.	Poland	8	2175	0.351	95.688
16.	Egypt	7	2182	0.307	95.996
17.	Germany	7	2189	0.307	96.304
18.	Japan	7	2196	0.307	96.612
19.	Finland	6	2202	0.263	96.876
20.	Ghana	6	2208	0.263	97.140
21.	Spain	5	2213	0.219	97.360
22.	Estonia	4	2217	0.175	97.536
23.	Indonesia	4	2221	0.175	97.712
24.	Lithuania	4	2225	0.175	97.888
25.	Malaysia	4	2229	0.175	98.064
26.	South Africa	4	2233	0.175	98.240
27.	Sweden	4	2237	0.175	98.416
28.	Greece	3	2240	0.131	98.548
29.	Nepal	3	2243	0.131	98.680
30.	Pakistan	3	2246	0.131	98.812
31.	Russia	3	2249	0.131	98.944
32.	Slovenia	3	2252	0.131	99.076
33.	Czech Republic	2	2254	0.087	99.164
34.	France	2	2256	0.087	99.252
35.	Iran	2	2258	0.087	99.34

36.	Ireland	2	2260	0.087	99.428
37.	Israel	2	2262	0.087	99.516
38.	Korea	2	2264	0.087	99.604
39.	Italy	2	2266	0.087	99.692
40.	Germany	1	2267	0.043	99.736
41.	Hungary	1	2268	0.049	99.780
42.	Myanmar	1	2269	0.049	99.824
43.	New Zealand	1	2270	0.043	99.868
44.	Tanzania	1	2271	0.043	99.912
45.	Turkey	1	2272	0.043	99.956
46.	UAE	1	2273	0.043	100

In this section, all the citation categorized to their country of origin to find out the most productive countries in the literature of Earth Science subject. The cited documents were analysed according to their country of origin. Table-3 indicates that 30.79% of the cited documents were from UK and the rest were from Netherlands (16.05%), USA (15.53%), India (10.29%) and remaining i.e. less than 9% were from other 42 countries. From this it can be inferred that the researchers in earth science depend much on literature emanating from UK, Netherland and USA.

Language-Wise Distribution of Journal Citations

Table 4. Language-Wise Distribution of Cited Journal Articles

Sl. No.	*Language*	*No. of Citations*	*Cumulative Citations (%)*	*Percentage (%)*	*Cumulative Percentage*
1.	English	2259	2259	99.384	99.384
2.	German	7	2266	0.307	99.692
3.	Russian	3	2269	0.131	99.824
4.	Slovene	3	2272	0.131	99.956
5.	French	1	2273	0.043	100

Further, the citations were analysed according to their language. The language-wise scattering of cited documents showed that English was the predominant language (99.384%) and the uses of other foreign language materials i.e. Russian (0.131%), Slovene (0.131%) and French (0.043%) were substantially lower. German language documents accounted for only 0.307% of citations (Table-4).

Subject-Wise Distribution of Journal

Table 5. Subject-Wise Distribution of Journal Citations

Sl. No.	*Subjects*	*Total No. of citations*	*Percentage of Citation (%)*	*Cumulative Citation*	*Cumulative Percentage (%)*
1	Geology	848	37.308	848	37.308
2	Petrology	247	10.867	1095	48.175
3	Geography	213	9.371	1308	57.546
4	General Science	152	6.687	1460	64.233
5	Environmental Sciences	117	5.147	1577	69.380
6	Sedimentology	73	3.212	1650	72.592

7	Hydrology	71	3.124	1721	75.715
8	Geophysics	44	1.936	1765	77.651
9	Others (Related Subjects)	43	1.892	1808	79.543
10	Remote Sensing	41	1.804	1849	81.347
11	Mining	40	1.760	1889	83.107
12	Ecology	34	1.496	1923	84.602
13	Medicine	34	1.496	1957	86.098
14	Agriculture	31	1.364	1988	87.462
15	Marine Science	31	1.364	2019	88.826
16	Waste Management	26	1.144	2045	89.970
17	Chemistry	20	0.880	2065	90.850
18	Regional Studies	20	0.880	2085	91.729
19	Environmental Engineering	19	0.836	2104	92.565
20	Petroleum Technology	19	0.836	2123	93.401
21	Solar and Wind	15	0.660	2138	94.061
22	Atmospheric Science	14	0.616	2152	94.677
23	Mineralogy	14	0.616	2166	95.293
24	Palaeontology	13	0.572	2179	95.865
25	Toxicology	13	0.572	2192	96.437
26	Geomorphology	11	0.484	2203	96.921
27	Climatology	6	0.264	2209	97.185
28	Forestry	6	0.264	2215	97.449
29	Psychology	6	0.264	2221	97.713
30	Civil Engineering	5	0.220	2226	97.933
31	Soil Science	5	0.220	2231	98.153
32	Biology	4	0.176	2235	98.329
33	Astronomy	4	0.176	2239	98.505
34	Environmental Chemistry	4	0.176	2243	98.681
35	Geochemistry	4	0.176	2247	98.857
36	Energy	4	0.176	2251	99.033
37	Botany	3	0.132	2254	99.165
38	Biochemistry	3	0.132	2257	99.297
39	Seismology	3	0.132	2260	99.429
40	Social Science	3	0.132	2263	99.561
41	Pharmacy	3	0.132	2266	99.693
42	Economics	2	0.088	2268	99.781
43	Sociology	2	0.088	2270	99.868
44	Pure and Applied Chemistry	2	0.088	2272	99.956
45	Statistics	1	0.044	2273	100.000
	Total	**2273**	**100.00**		

The Table-5 depicts the subject wise distribution of journals citations in Earth Science Ph.D Theses. The total 2273 citations of journals are scattered primarily among 45 subjects. However 37.3% is connected in one major subject fields i.e. Geology as majority of Ph.D theses under

citation study related to this subject. Journal on the subject citation on Botany, Biochemistry, Seismology, Social Science, Pharmacy, Economics, Sociology, Pure and Applied Chemistry and Statistics are small in number and together which represents 0.968% of total number of citations.

Bradford's Law of Scattering and Analysis of Bradford's Zones

Bradford's law serves as a general guideline to librarians in determining the number of core journals in any given field. It states that journals in a single field can be divided into three zones, each zone containing the same number of citations (Bibliometric Laws, 2012):

a) Core journals on the given subject, relatively few in number that produces approximately one-third of all the articles.
b) A second zone, containing the same number of articles as the first, but a greater number of journals.
c) A third zone, containing the same number of articles as the second, but a still greater number of journals.

The mathematical relationship of the number of journals in the core to the first zone is a constant 'n' and the second zone of relationship is n^2. Bradford expressed this relationship as

1: n: n^2. The number of journals in each Bradford's zone can be calculated from multiplier constant k that is called Bradford constant using the formulation of Egghe (1986):

$$\boldsymbol{k} = (e^{\gamma} \mathbf{x} \boldsymbol{Y_m})^{\mathbf{1}/\boldsymbol{p}}$$

Where $\boldsymbol{\gamma}$ is Euler's number having value of 0.57772; Y_m is the number of citation of rank one journal; p is Bradford group or number of zones (p=3). From Table-7, the number of highest citation is 221. **e** = 2.718

T= Total Number of Journals

So that,

$$k = (2.718^{0.5772} X\ 221)^{1}/_{3} = (1.781\ X\ 221)^{1}/_{3} = 7.3286$$

$$r_0 = \frac{T(k-1)}{k^p - 1} = \frac{408(7.3286 - 1)}{7.3286^3 - 1} = \frac{2582.0688}{392.6072} = 6.5767$$

$$r_0 = 6.5767, r_1 = r_o X k$$

Nucleus zone $r_0 = r_0\ X\ 1 = 6.5767$; **first zone** $r_1 = 6.5767X\ 7.3286 = 48.1980$; **second zone** $r_2 = r_0\ Xk^2 = 6.5767\ X7.3286^2 = 353.2240$

According to Bradford zones, thus identified in the form 1: n: n^2 in the present study, the relationship of each zone is 9: 46: 353.

Table 6. Bradford's Zones and Their Number of Journals

Zone	*No. of Journals*	*Cumulative No. of Journals*	*Journal %*	*No. of Citations*	*%*	*Cumulative No. of Citations*	*Cumulative %*
I	9	9	2.21	789	34.71	789	34.71
II	46	55	11.27	761	33.48	1550	68.19
III	353	408	86.52	723	31.81	2273	100.00
	408		100.00	2273	100.00		

The scattering of journals according to Bradford's described zones (on approximation) are:

Zone 1 (Core Nucleus) : 9 Journals with 789 Citations. **Zone 2 :** 46 Journals with 761Citations.
Zone 3 : 353 Journals with 723 Citations.

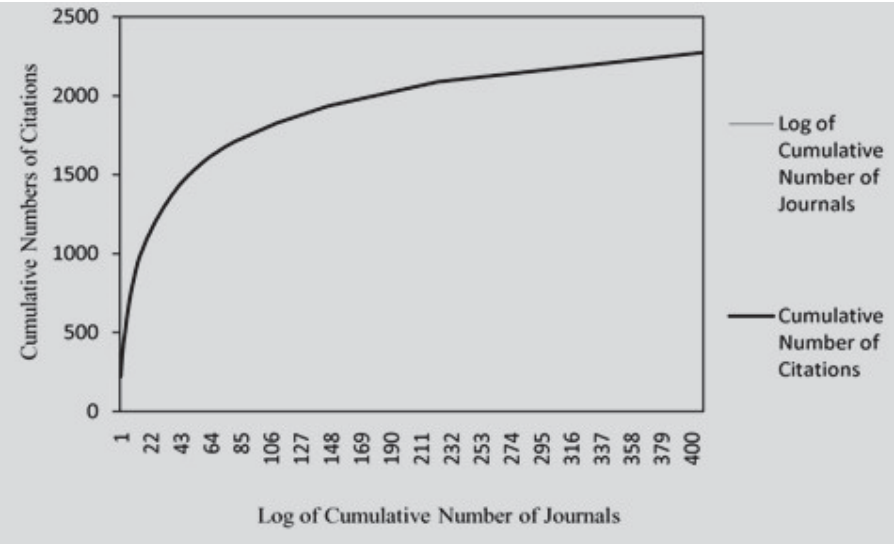

Figure 1.Bradford's Graph

Table 7. Ranking of Journals in Earth Science

Sl. No.	*Rank*	*Journal Title*	*No. of Citations*	*Cumulative Citations*	*%*	*Cumulative Percentage*	*Log N*
1	1	Journal of Sedimentary Petrology	221	221	9.723	9.72	0.000
2	2	Journal of Geology	131	352	5.763	15.49	0.693
3	3	Tectonophysics	82	434	3.608	19.09	1.099
4	4	Geochimica et Cosmochimica Acta	73	507	3.212	22.31	1.386
5	5	Journal of Geophysical Research	71	578	3.124	25.43	1.609
6	6	American Journal of Scientific Research	59	637	2.596	28.02	1.792
7	6	Himalayan Geology	59	696	2.596	30.62	1.946
8	7	Journal of Geological Society of London	48	744	2.112	32.73	2.079
9	8	Geographical Review of India	45	789	1.980	34.71	2.197
10	8	Journal of Structural Geology	45	834	1.980	36.69	2.303
11	9	Journal of Geological Society of India	42	876	1.848	38.54	2.398

12	10	Indian Journal of Earth Sciences	35	911	1.540	40.08	2.485
13	10	National Geographical Journal of India	35	946	1.540	41.62	2.565
14	11	Chemical Geology	27	973	1.188	42.81	2.639
15	12	Indian Journal of Environment and Ecoplanning	25	998	1.100	43.91	2.708
16	13	Sedimentology	23	1021	1.012	44.92	2.773
17	14	Pollution Research	22	1043	0.968	45.89	2.833
18	14	Waste Management	22	1065	0.968	46.85	2.890
19	15	Current Science	21	1086	0.924	47.78	2.944
20	16	Nature	20	1106	0.880	48.66	2.996
21	17	Geology	19	1125	0.836	49.49	3.045
22	17	Transaction American Geophysical Union	19	1144	0.836	50.33	3.091
23	18	Engineering Geology	18	1162	0.792	51.12	3.135
24	18	Quarterly Journal of Geological, Mining and Metallurgical Society of India	18	1180	0.792	51.91	3.178
25	19	Journal of Geological Society of Australia	17	1197	0.748	52.66	3.219
26	19	Journal of Geophysics	17	1214	0.748	53.41	3.258
27	20	Indian Journal of Landscape Systems and Ecological Studies	16	1230	0.704	54.11	3.296
28	20	International Journal of Remote Sensing	16	1246	0.704	54.82	3.332
29	21	3 Journals are with 21st rank	45	1291	1.980	56.80	3.367
30	22	4 Journals are with 22nd rank	56	1347	2.464	59.26	3.401
31	23	2 Journals are with 23rd rank	26	1373	1.144	60.40	3.434
32	24	4 Journals are with 24st rank	48	1421	2.112	62.52	3.466
33	25	2 Journals are with 25th rank	22	1443	0.968	63.48	3.497
34	26	3 Journals are with 26th rank	30	1473	1.320	64.80	3.526
35	27	5 Journals are with 27th rank	45	1518	1.980	66.78	3.555
36	28	8 Journals are with 28th rank	64	1582	2.816	69.60	3.584
37	29	4 Journals are with 29th rank	28	1610	1.232	70.83	3.611

38	30	11 Journals are with 30th rank	66	1676	2.904	73.74	3.638
39	31	6 Journals are with 31st rank	30	1706	1.320	75.06	3.664
40	32	30 Journals are with 32nd rank	120	1826	5.279	80.33	3.689
41	33	36 Journals are with 33rd rank	108	1934	4.751	85.09	3.714
42	34	77 Journals are with 34th rank	154	2088	6.775	91.86	3.738
43	35	85 Journals are with 35th rank	185	2273	8.139	100.00	3.761
		Total	**2273**		**100**		

Findings and Conclusion

The following are the major findings drawn from this study.

Distribution of Citations

- According to the analysis of citation in Earth Science reveals that journals appears to be the most preferred sources of information used by the researchers which occupied 37.18% of the total citations. It shows that the research scholars in earth science mainly used journals for collecting the information.
- U.K. (30.79%) attained the first rank in country wise analysis of citations in earth science.
- English language occupied the first place with 99.38% in the language-wise analysis of citations in earth science.
- It was found that the total 2273 citations of journals are scattered primarily among 45 subjects and 37.3% is connected in one major subject fields i.e. Geology as majority of Ph.D theses under citation study related to this subject.

Bradford's Law of Scattering and Analysis of Bradford's Zones

- The study reveals that 9 (Nine) Core journal which were the source journals leads the majority of the citations with a total of 789 Citation, 46 (Forty Six) journal with the total citation of 761 which were first zone of the Bradford zone and 353 journal with the citation of 723 which were the second zone of the Bradford zone of scattering respectively.

Suggestions and Conclusion

The present study is based on the Citations rendered in Ph.D theses of Earth Science submitted to Manipur University only. Analogous type of research may be carrying out covering the theses in other science subjects and social science subjects. This is to simplify the findings of the study and expand in-depth information of the literature used by the researchers. The Manipur University Library should subscribe those foreign print/e-journals and Indian journals to meet the needs of the research scholar, students and teachers. The Citations from other forms of documentation concerned i.e. e-resources, reports, conference proceedings; records, thesis, government publication etc are very less cited and used because of the insufficiency of information. In this regard it is suggested that concerned authorities should make an effort to overcome these restrictions by providing efficient library services. This would help the researchers not only in the field of earth science, but also in other fields of knowledge to get the required materials for their research purpose. University libraries in the state of Manipur should build a consortium to share their print and electronic resources available in their libraries.

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